NC STATE UNIVERSITY

Center for Human Health and the Environment

Center for the Environmental and Health Effects of PFAS

The GenX Exposure Study Update

Jane Hoppin, ScD

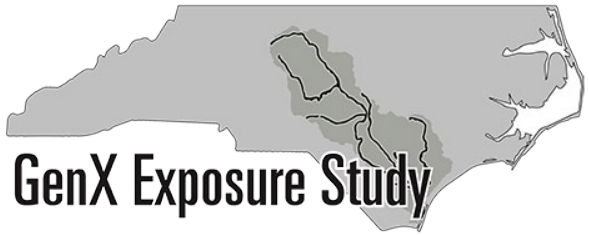
Professor, Biological Sciences

Deputy Director, CHHE

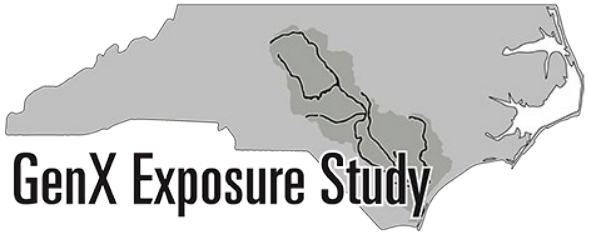
GenX Exposure Study

Outline

- GenX Exposure Study
  - How did it start?
  - What did we find?
- National Academies' recommendations
  - How does NC compare
- Where are we going?
  - Health Study
  - Sharing PFAS results



GenX Exposure Study



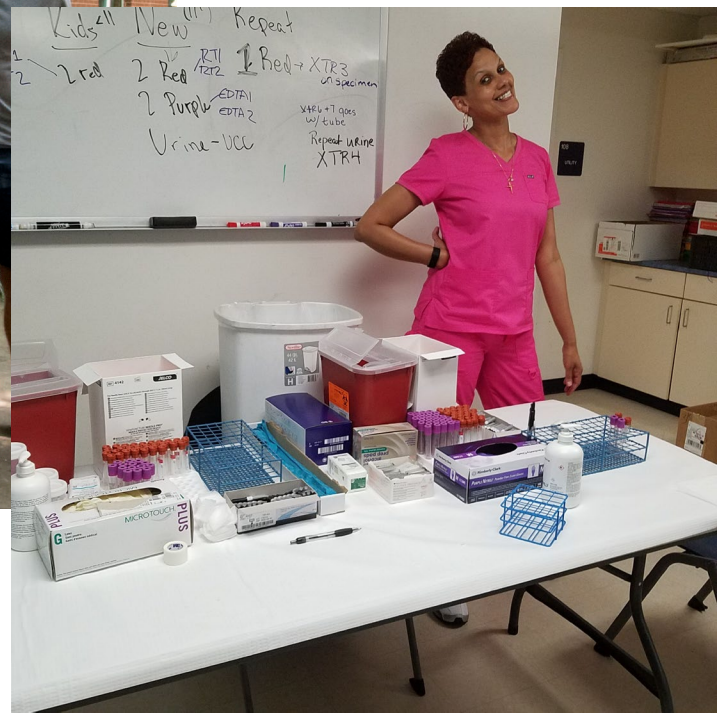
Designed to answer community questions about GenX and other PFAS exposure

Is GenX detectable in my body?
What predicts GenX in my body?
Are there health effects associated with GenX?

Started in Wilmington in November 2017,
Fayetteville in February 2019

Initially funded by NIEHS through their time sensitive grants program.

So what did we do?



GenX Exposure Study

GenX Exposure Study Design: 2017-2018

Enrolled Wilmington residents on Cape Fear Public Utility Authority water, ages 6 and older, November 2017 + May 2018

- 344 total

Collected blood and drinking water

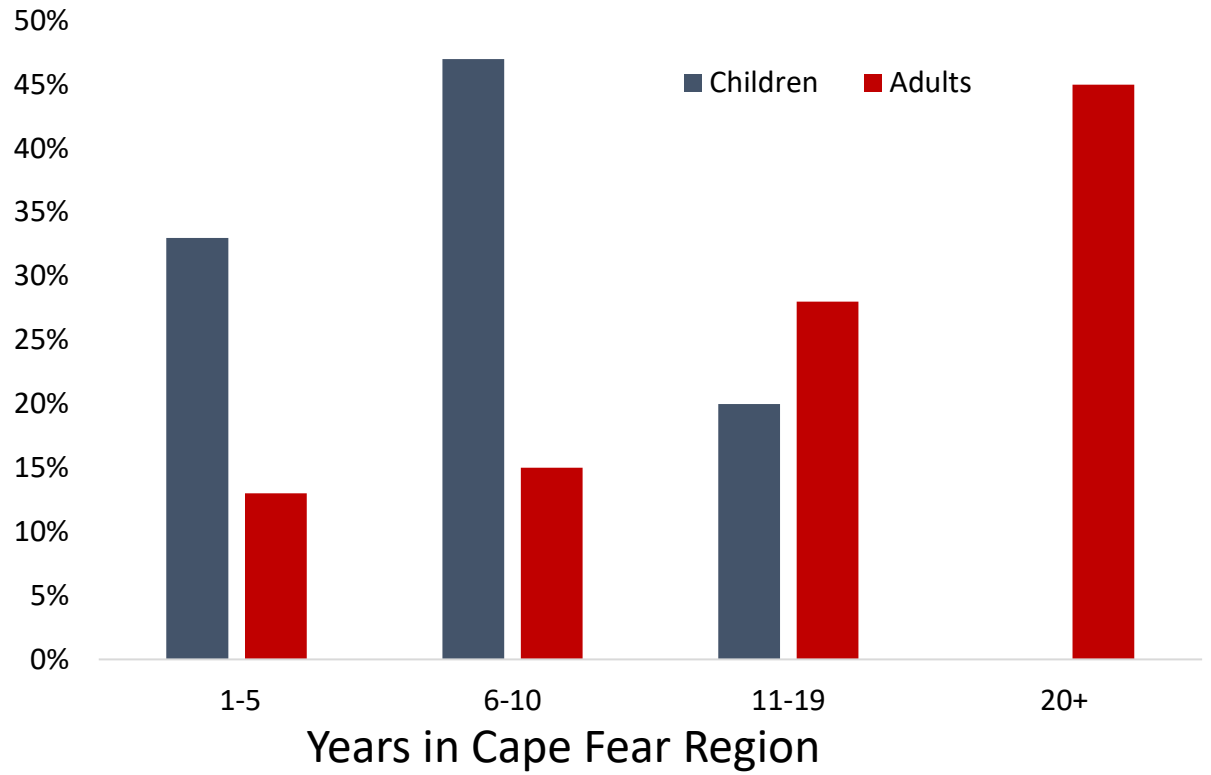
- Analyzed for GenX and other PFAS
- Analyzed blood samples for thyroid hormones, lipids

Collected questionnaire information on residential history and medical conditions.

Reported back results

Who Participated? Wilmington, 2017-2018

- 344 individuals
  - 289 adults
  - 55 children (6-17 years)
- Racially diverse
  - 76% White
  - 10% Black
  - 9% Hispanic
  - 5% Other



GenX Exposure Study

PFAS Blood Results: Wilmington, 2017-8

We detected 7 PFAS in the blood of almost everyone

Three brand new PFAS

- Nafion byproduct 2
- PFO4DA
- PFO5DoA

We did not detect GenX in anyone.

Legacy PFAS

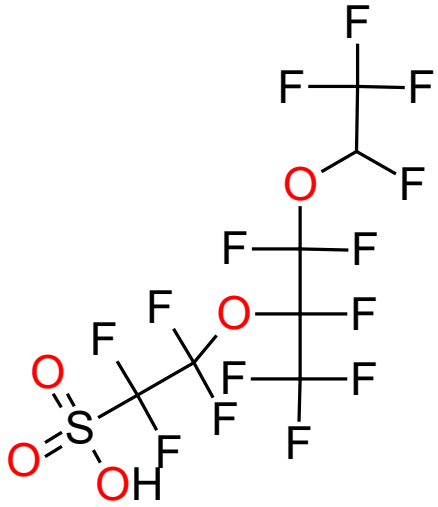
- PFOA
- PFOS
- PFNA
- PFHxS

Also: PFO3OA, NVHOS, Hydro-Eve detected in a subset

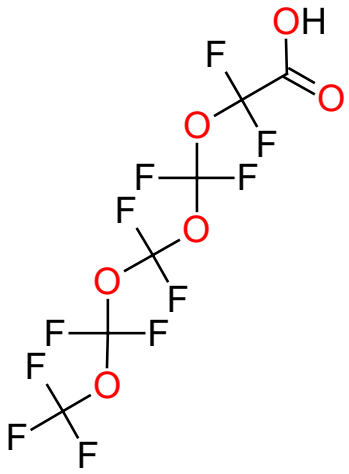
Kotlarz et al, Environ Health Perspect, 2020

Three long chain fluoroethers in Wilmington blood

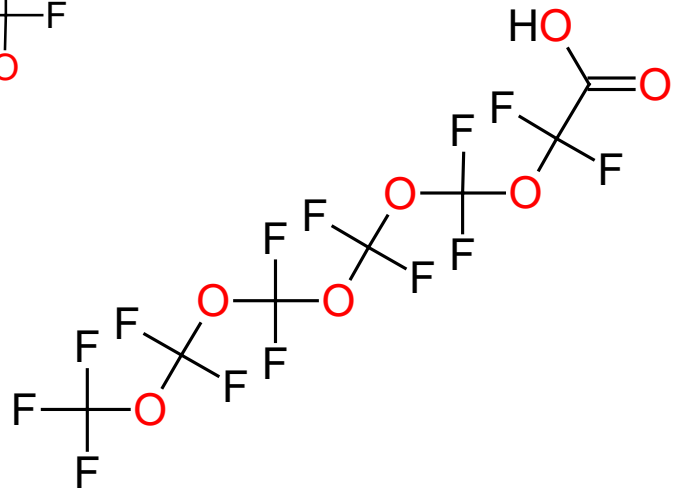
1. Nafion byproduct 2 (99%)



2. PFO4DA (98%)

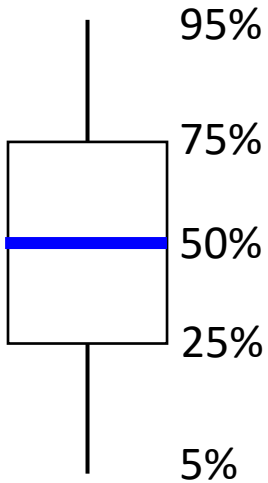


3. PFO5DoA (87%)

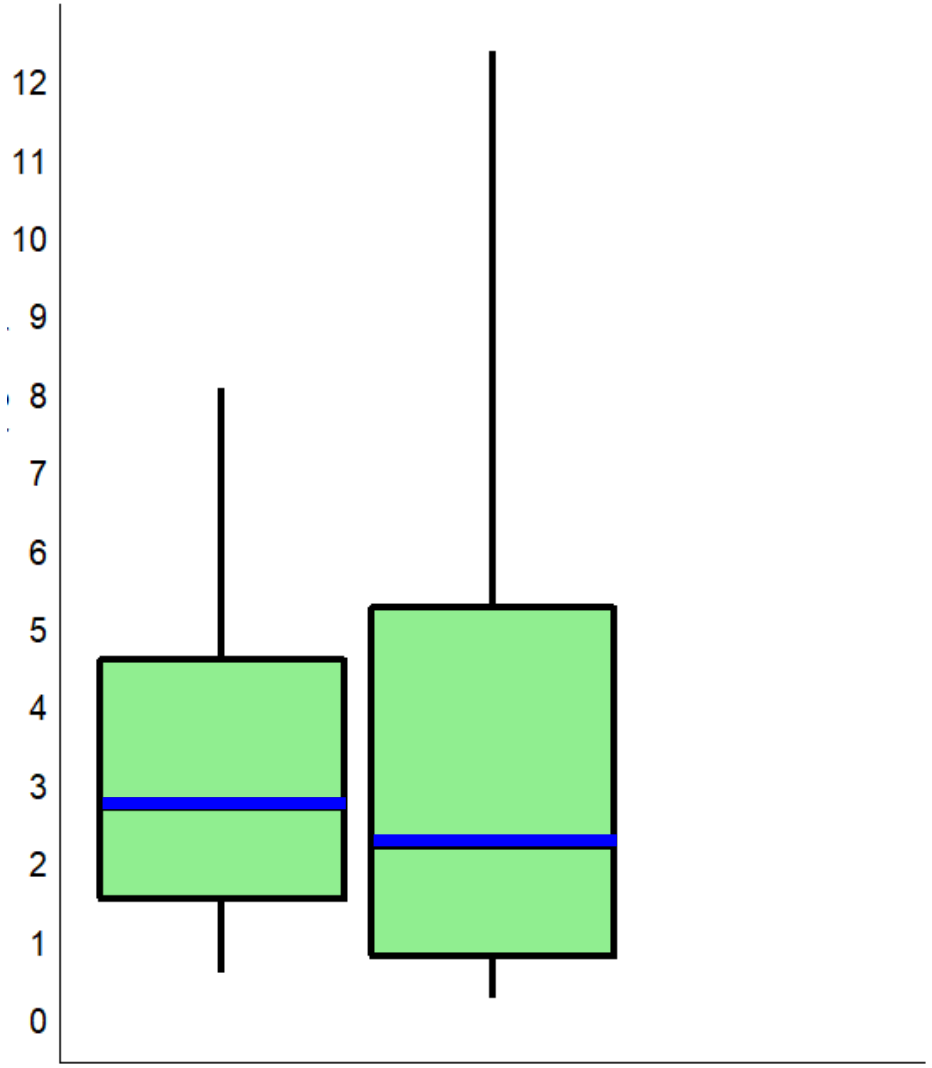


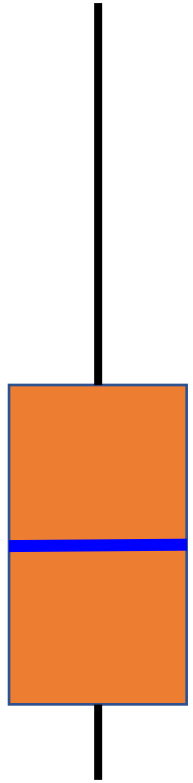
GenX Exposure Study

How much was found?



Blood concentration (ng/mL)





PFOA

GenX Exposure Study

Comparing the levels of legacy PFAS

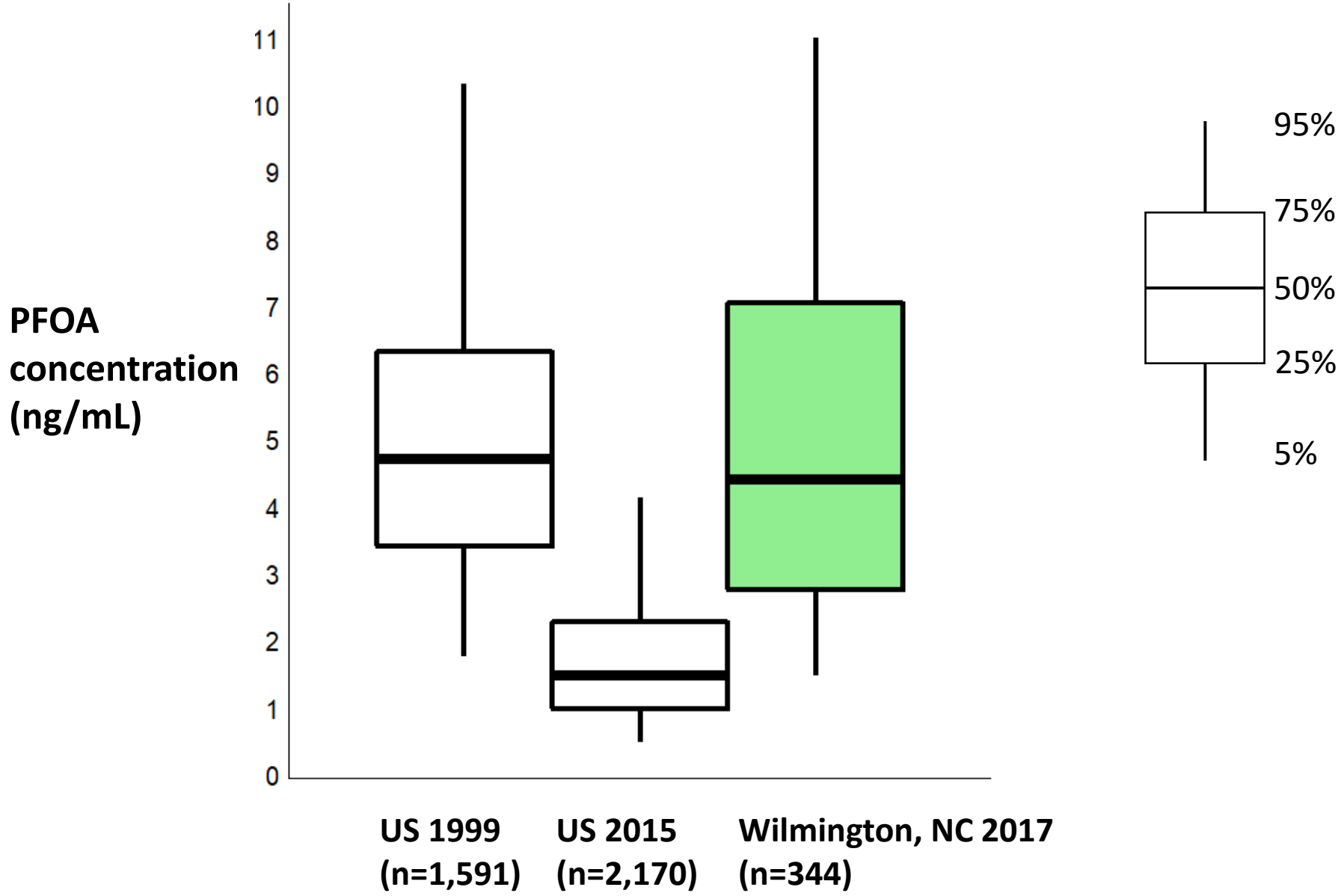
Centers for Disease Control and Prevention's National Health and Nutrition Examination Survey (NHANES)

PFOA, PFOS, PFHxS, PFNA results are publicly available

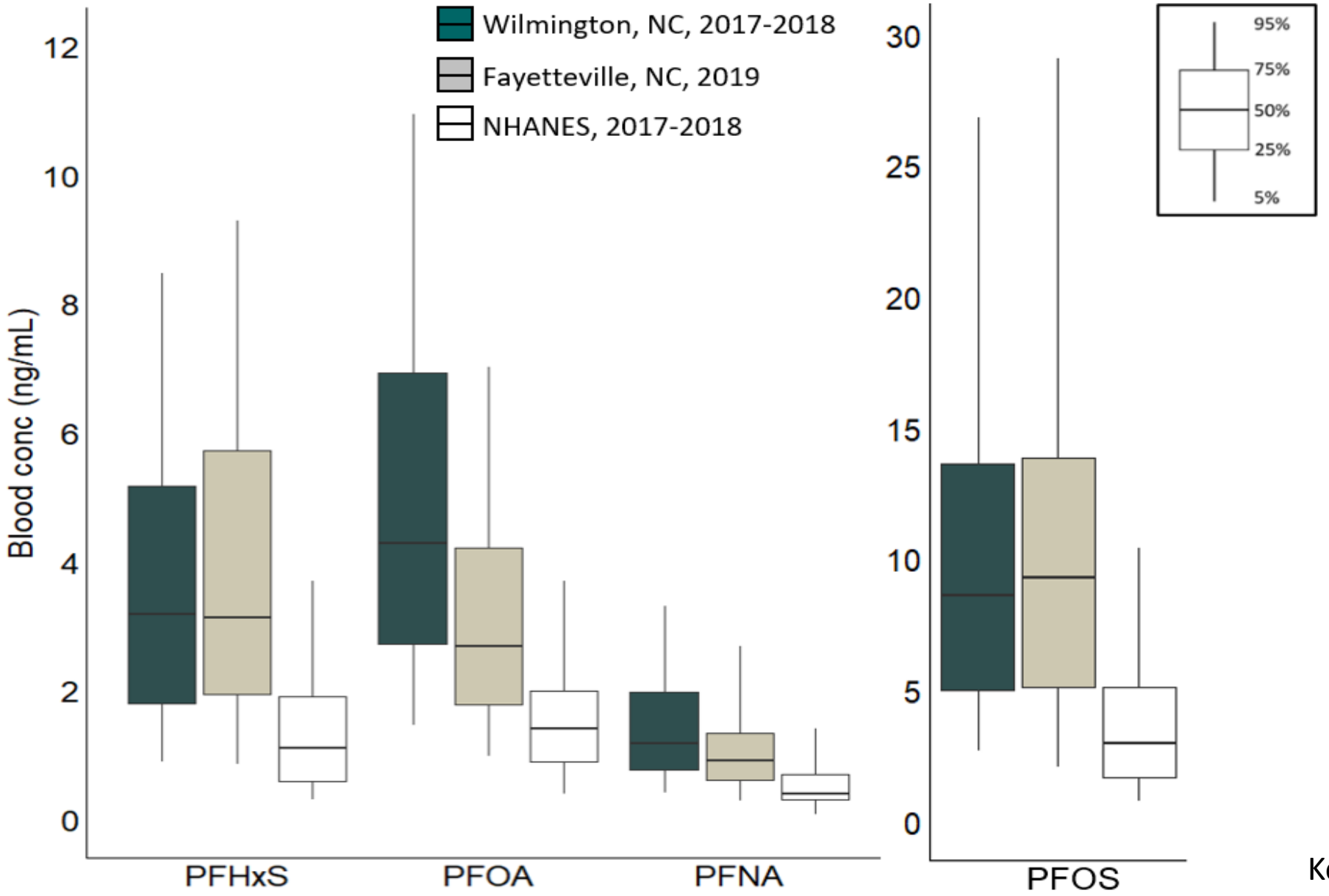
1999-2000 survey

2015-2016 survey

Elevated PFOA in Wilmington blood, 2017-8



Comparison of Legacy PFAS from two communities in the Cape Fear Basin to NHANES, 2017-2018



Kotlarz et al, in prep

How much do fluoroethers contribute to overall PFAS exposure?

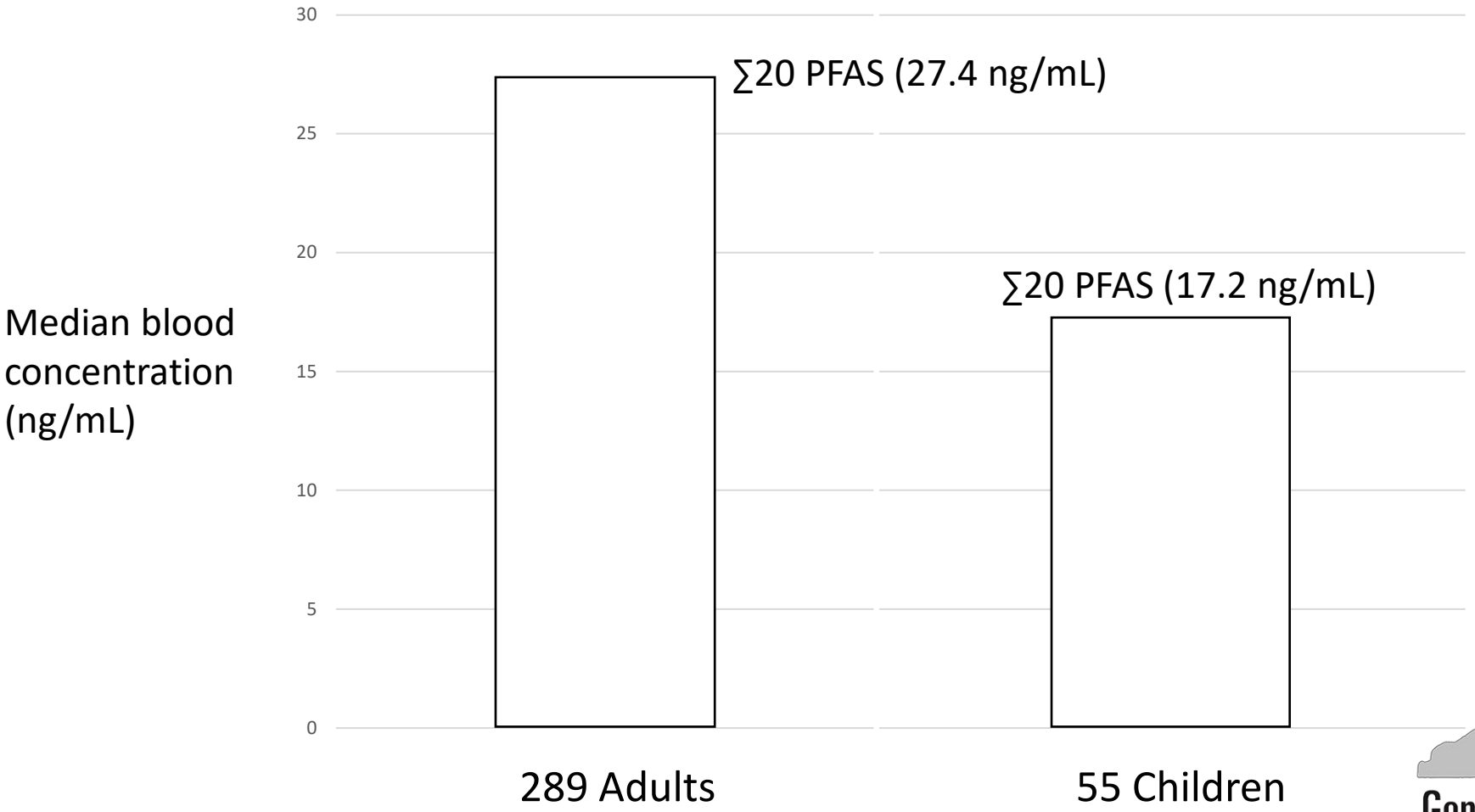
We quantified ten fluoroethers and ten legacy PFAS.

We detected another fluoroether “Hydro-Eve” but could not quantify.

Summing all detected PFAS may miss total PFAS contribution

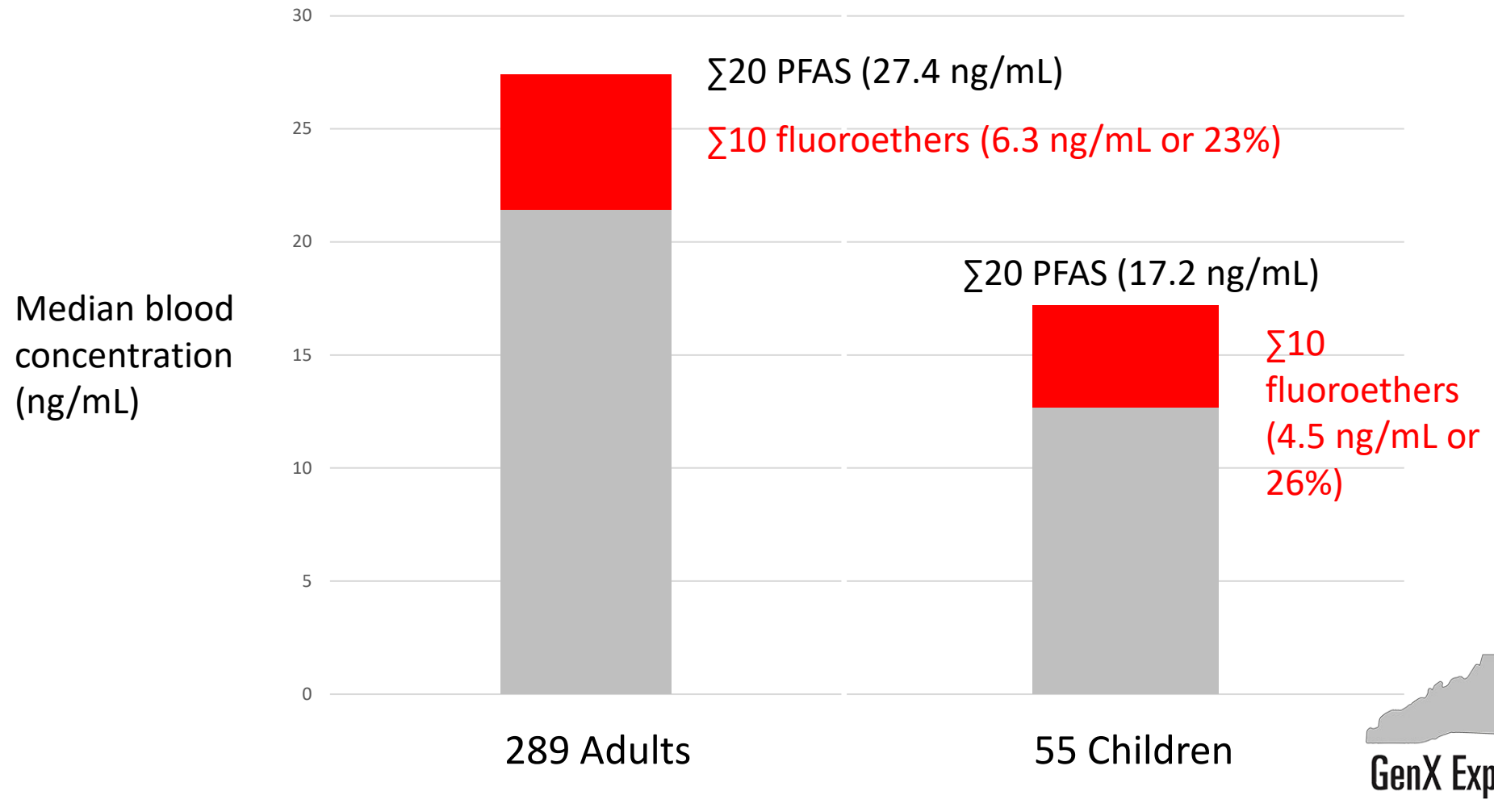
GenX Exposure Study

Total measured PFAS in blood, Wilmington, NC 2017-2018



GenX Exposure Study

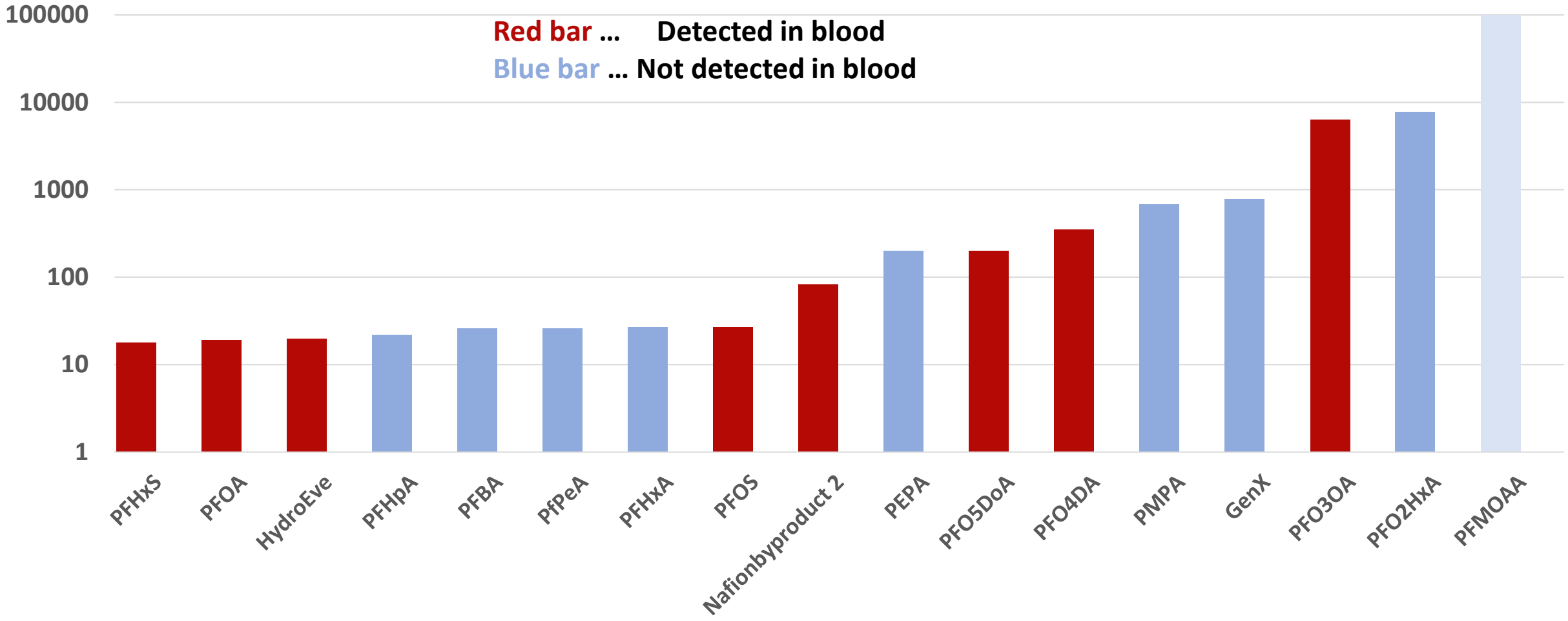
Fluoroethers contributed substantially to ∑PFAS in Wilmington blood



GenX Exposure Study

What do we miss when we use blood as a marker of exposure?

PFAS levels in Cape Fear River water (ng/L) in 2015



Adapted from Zhang et al., ES&T Letters, 2019

NATIONAL ACADEMIES Sciences Engineering Medicine

Guidance on PFAS Exposure, Testing, and Clinical Follow-Up

July 2022

https://www.nationalacademies.org/our-work/guidance-on-pfas-testing-and-health-outcomes

Health Effects of PFAS: Conclusions

Sufficient evidence of an association

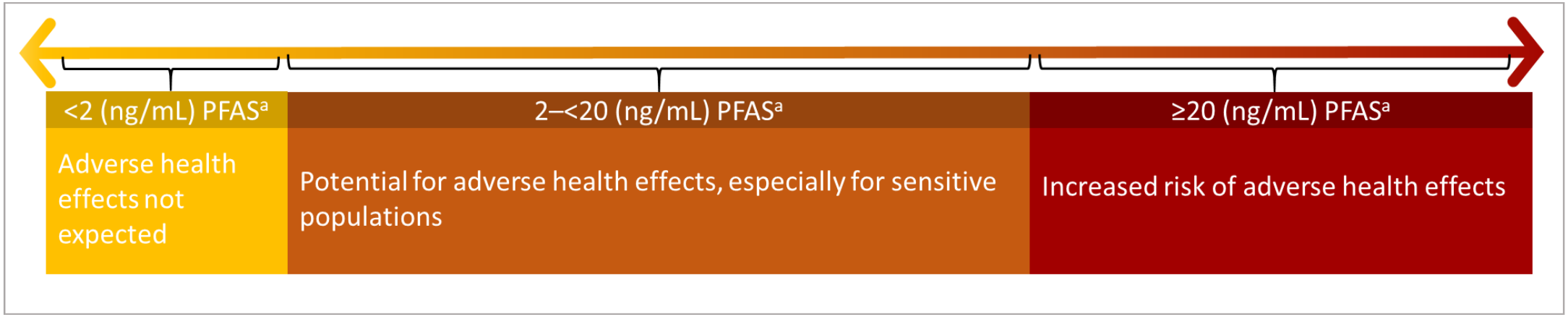
- Decreased antibody response (in adults and children)
- Dyslipidemia (in adults and children)
- Decreased infant and fetal growth
- Increased risk of kidney cancer (in adults)

Limited suggestive evidence of an association

- Increased risk of breast cancer (in adults)
- Increased risk of testicular cancer (in adults)
- Liver enzyme alterations (in adults and children)
- Increased risk of pregnancy-induced hypertension (gestational hypertension and preeclampsia)
- Thyroid disease and dysfunction (in adults)
- Increased risk of ulcerative colitis (in adults)

NASEM 2022

PFAS Testing and Concentrations that Can Inform Clinical Care Recommendations



Recommendation 5-3: Clinicians should use serum or plasma concentrations of the sum of PFAS* to inform clinical care of exposed patients, using the following guidelines for interpretation:

- Adverse health effects related to PFAS exposure are not expected at less than 2 nanograms per milliliter (ng/mL).
- There is a potential for adverse effects, especially in sensitive populations, between 2 and 20 ng/mL.
- There is an increased risk of adverse effects above 20 ng/mL.

*Simple additive sum of MeFOSAA, PFHxS, PFOA (linear and branched isomers), PFDA, PFUnDA, PFOS (linear and branched isomers), and PFNA in serum or plasma. Caution is warranted when using capillary blood measurements as levels may differ from serum or plasma levels.

NASEM 2022

NASEM 2022

PFAS Exposure: Clinical Follow-Up

- Clinicians should offer PFAS testing to patients who are likely to have a history of elevated exposure. In all discussions of PFAS testing, clinicians should describe the potential benefits and harms of PFAS testing and the potential clinical consequences (such as additional follow-up), related social implications, and limitations of the testing so patient and clinician can make a shared, informed decision.
- If testing is done the clinician should compare its results with the chart below and discuss treatment accordingly.

<2 (ng/mL) PFAS*	2–<20 (ng/mL) PFAS*	≥20 (ng/mL) PFAS*

Provide usual standard of care.	Encourage PFAS exposure reduction if a source has been identified, especially for pregnant persons.
	
	Within the usual standard of care clinicians should:
	• Prioritize screening for dyslipidemia with a lipid panel (once between 9 and 11 years of age, and once every 4 to 6 years over age 20) as recommended by the American Academy of Pediatrics (AAP) and American Heart Association (AHA).
	• Screen for hypertensive disorders of pregnancy at all prenatal visits per the American College of Obstetricians and Gynecologists (ACOG).
	• Screen for breast cancer based on clinical practice guidelines based on age and other risk factors such as those recommended by US Preventive Services Task Force (USPSTF).
		Encourage PFAS exposure reduction if a source of exposure is identified, especially for pregnant persons.
		
		In addition to the usual standard of care, clinicians should:
		• Prioritize screening for dyslipidemia with a lipid panel (for patients over age 2) following AAP recommendations for high-risk children and AHA guidance for high-risk adults.
		• At all well visits:
		  • Conduct thyroid function testing (for patients over age 18) with serum thyroid stimulating hormone (TSH),
		  • Assess for signs and symptoms of kidney cancer (for patients over age 45), including with urinalysis, and
		  • For patients over age 15, assess for signs and symptoms of testicular cancer and ulcerative colitis.

* Simple additive sum of MeFOSAA, PFHxS, PFOA (linear and branched isomers), PFDA, PFUnDA, PFOS (linear and branched isomers), and PFNA in serum or plasma

Summed serum PFAS levels for adverse health effects

≥ 20 ng/mL summed PFAS

Higher risk of adverse effects
Reduce exposure
Also test for thyroid function, kidney and testicular cancer, ulcerative colitis

Over half of adults exceeded 20 ng/mL
Median value for summed PFAS = 20.8 ng/mL

2 - <20 ng/mL summed PFAS

Potential for adverse effects in sensitive populations
Reduce PFAS exposure
Screen for dyslipidemia, hypertensive disorders of pregnancy, and breast cancer

Most children in this range (~90%)
Median value for summed PFAS = 11.3 ng/mL
(IQR = 11.1, 28.7)

~Half of adults within this range

< 2 ng/mL summed PFAS

Adverse health effects not expected.
Recommend usual standard of care.

Kotlarz et al. Environ Health Perspect, 2020

Are PFAS associated with cholesterol levels in the GenX Exposure Study?

Emma Rosen, UNC doctoral student

Methods

Exposure, outcome, covariate data available for 326 Wilmington participants

Measured total, HDL, LDL cholesterol & triglycerides

- Calculated non-HDL cholesterol to account for variability in participant fasting status

Inverse probability of treatment weighting to account for confounding

Assessment of effect modification by participant age

Main findings

Legacy PFAS, especially PFOS and PFNA, were associated with higher levels of non-HDL cholesterol, total cholesterol, LDL cholesterol

- Consistent with other studies

Nafion byproduct 2 and PFO5DoDA were associated with higher levels of HDL cholesterol

- No other fluoroether associations noted

Results larger in magnitude with increasing age

- Strongest among those 63—86 years old

Rosen et al, Environ Health Perspect, 2022

Next Steps

Center for Environmental and Health Effects of PFAS (NC State Superfund Center)

The NC State Superfund Center is focusing on several key areas to advance understanding about PFAS -

- **Exposure** in NC communities and environment
- Toxicity and underlying mechanisms of **thyroid** and **immune** function
- **Bioaccumulation** potential
- **Remediation**

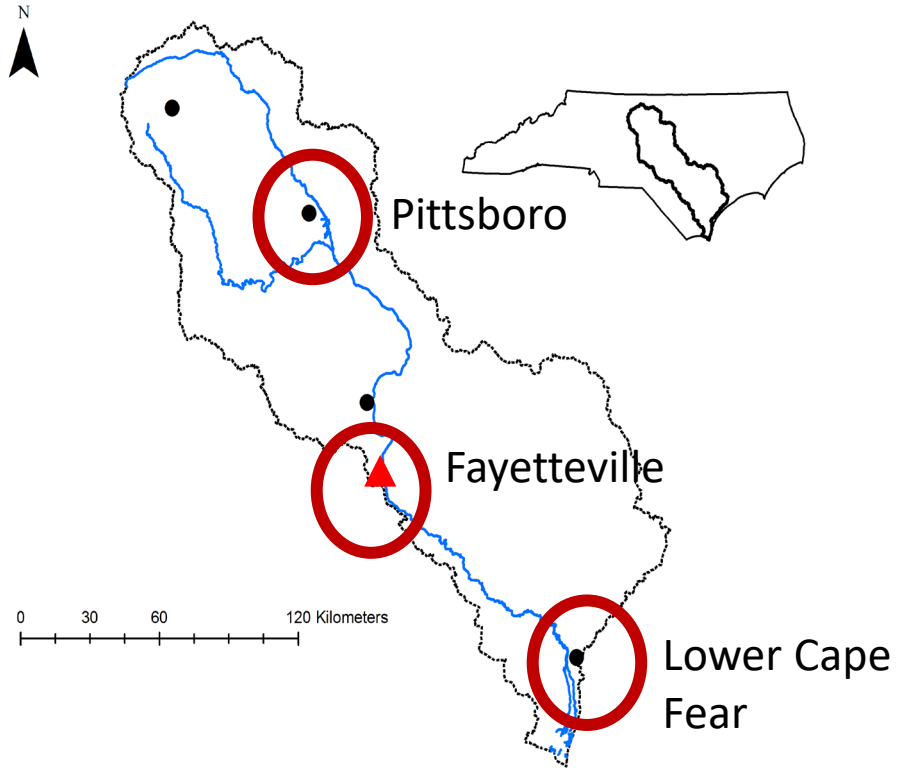
Transition from an Exposure Study to a Health Study

Grow from 500 participants to 1020 participants throughout the Cape Fear Basin

- Lower Cape Fear area
- Fayetteville area
- Pittsboro

Five-year study

- 2 blood collection events
- Measure PFAS
- Measure thyroid hormones
- Measure response to COVID/vaccine



Next Steps: PFAS Results Reporting

Looked for over 40 PFAS in 1020 participants' blood samples

Report back PFAS blood results to 1020 participants

- Enrolled in 2020-2021
- New Hanover + Brunswick Counties
- Fayetteville Private Well community (Bladen, Cumberland, and Robeson)

Webinar for all interested people in October 2022

Community meetings in late October – November 2022

NC STATE UNIVERSITY
Center for Human Health and the Environment

Acknowledgements

GenX Exposure Study

NC State University

Jane Hoppin, PI
Nadine Kotlarz
Detlef Knappe
Katy May
Rob Smart
Zachary Hopkins
Claire Critchley
Dylan Wallis
Michael Cuffney

East Carolina University

David Collier
Jamie DeWitt
Suzanne Lea

US EPA

Andrew Lindstrom
James McCord
Mark Strynar

Community partners

New Hanover County Health Department

Chatham County Health Department

Cumberland County Health Department

Cape Fear River Watch

Sustainable Sandhills

Haw River Assembly

New Hanover County NAACP

UNCW Latino Alliance

Funding: NIEHS R21 R21ES029353, P42ES031009
CHHE P30ES025128
Matching Funds from NC Policy Collaboratory

https://genxstudy.ncsu.edu/

Thank you …. Any questions?

Feel free to reach out

jahoppin@ncsu.edu

Genxstudy.ncsu.edu